Final Technical Report

CONFERENCE ON FUNDAMENTAL OPTICAL PROCESSES IN SEMICONDUCTORS

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1. Summary

The meeting on Fundamental Optical Processes in Semiconductors (FOPS) was held between July 23-27, 2007 at Big Sky, Montana. The aim of the conference is to bring together the leading international groups working in semiconductor optics in a workshop format to present the most recent exciting results and to discuss the future directions of the field. The conference has been well attended with about 90 participants. The conference has also been able to attract the active participation of a relatively large number of graduate students and provide ample opportunities for the students to interact with the experts of the semiconductor optics community.

2. List of participants supported by the AFOSR grant

Dan Allen, student, UCSB
Junko Omachi, student, Univ of Tokyo
Xiaodong Xu, student, Univ. of Michigan
Sen Yang, student, UCSD
David Gershoni, Professor, Technion, Israel
Ilias Perakis, Professor, Univ. of Crete, Greece
Pierre Petroff, Professor, UCSB

3. Conference Committee

Conference Co-Chairs:
Hailin Wang, University of Oregon
Rolf Binder, University of Arizona

Steering Committee:
David Citrin, Georgia Institute of Technology
Steve Cundiff, JILA/University of Colorado/NIST
Galina Khitrova, University of Arizona
Theodore Norris, University of Michigan

Advisory Committee:
Weng Chow, Sandia National Laboratory
Benoit Deveaud, EPFL, Lausanne
Daniel Gammon, Naval Research Laboratory
David Gershoni, Technion—Israel Institute of Technology
Atac Imamoglu, ETH, Zurich
Mackillo Kira, Phillips University, Marburg
Makoto Kuwata-Gonakami, University of Tokyo
David Snoke, University of Pittsburgh
Henry van Driel, University of Toronto

4. Feedbacks from the participants

The format of the conference stimulated scientific interactions among the participants and especially gave students the opportunity to interact with the leaders in their field. The success of the conference is reflected in a survey from the conference participants. Here are some excerpts:

Duncan G. Steel, The University of Michigan

My students said it was the best meeting they have been, too. That sounds pretty strong to me. Better than a Gordon conference.

Xiaoqin (Elaine) Li, University of Texas at Austin

It bought together the world leaders in the field of semiconductor optics, who presented exciting and the most recent result in this dynamic field. The conference has also given young researchers an opportunity to interact with many experts in the field. As a new assistant professor, I personally enjoyed this great opportunity to discuss some of my research ideas with several experienced researchers. The lodging and dinning arrangement had provided ample opportunities for the conference participant to interact with each other.

Ryan Smith, grad student, JILA

I found the environment very well setup for interaction between scientists, and the time during the day very helpful for getting organized, and stepping back from the concepts for a bit. I enjoyed the intention of the discussion sessions, but they were often disorganized. I don't know what to recommend in terms of a balance between spontaneity for conversation and structure. Overall, a very memorable conference!

Pierre Petroff, University of California, Santa Barbara

Very good mix of excellent speakers and discussions with attendees (including with students). I hope this meeting continues to exist. The field is well and alive and hopefully we will start seeing industrial applications.

Shanna Crankshaw, Ph.D Student, Berkeley

In many ways, FOPS was unlike any other conference/workshop I'd ever been to, and fortunately those ways were all positive. The single-speaker, all-invited talk format was a stark and refreshing contrast to events like CLEO/QELS which have so many parallel sessions that you're constantly, hectically searching the program to figure out what talk not to miss in the next fifteen minutes of your life. In that sense, FOPS was the least stressful conference I've ever attended. And perhaps professors don't see it that way, but for me, from the student's point of view, actually being able to focus solely on what the speakers were saying was almost something of a novelty. And given the exceptionally distinguished speaker list, this was a real privilege.

Having a small conference where students and speakers stay in the same hotels and have meals

in the same places forced (in a most welcome manner) an impressive level of interaction. (Note, having the professors in the "nice" wing of the same hotel as students just isn't quite the same.) Again, maybe this is what professors typically do. But for me, this was the first conference where I felt like I was actually part of that academic community, as someone who had much to learn but also something to say--a sentiment directly attributable to the utter lack of hierarchy. The relative isolation and natural beauty of the venue (as much as you can call anywhere with free wi-fi isolated) was frosting on the cake, so to speak.

Bejamin Richards, Ph.D Student, University of Arizona

The 2007 FOPS conference in Big Sky I am confident I will always remember as one of the highest points, along with FOPS 2004 in Estes Park, of my graduate student career. The environment and interaction with the other scientists was tremendously stimulating. From the graduate students to the most prestigious theorists, everyone I talked to was very friendly and open and helpful in discussing the science. I truly felt like a member of the community, and my motivation and enthusiasm for pursuing new avenues in the lab increased tremendously. I think that both of these conferences have been truly instrumental in my professional development, and I do not believe that I have any other experiences as a student that I value more highly.

Jigang Wang, Ph.D Student Lawrence Berkeley National Laboratory

The 2007 FOPS conference is one of the best conferences I have ever had. It has very interesting topics, great speakers and clear vision for semiconductor optics. My scientific interactions to other participants are extremely enjoyful. Thank you so much for putting together such a great conference and generous travel supports!

5. Attachment

A website has been setup for the conference, http://www.optics.arizona.edu/fops/, which includes information on the complete conference proceeding. The conference participation list and schedule are attached herewith.

Invited Presentations

Monday, July 23, 2007

Novel Phenomena

Smirl	Quantum Interference Goes Ballistic: The Dynamics of Spin and Charge Currents
Heinz	Recent Advances in the Optical Spectroscopy of Carbon Nanotubes
Steel	Optically Driven Electrons in Quantum Dots
Sheik-Bahae	Solid-State Laser Cooling by Luminescence Upconversion

Metamaterials

Wegener	Photonic Metamaterials: Optics Starts Walking on Two Feet
Giessen	Metallic Photonic Crystals
Citrin	Nanoplasmonic Waveguides
Woggon	Single CdSe Nanocrystals for Concepts of Cavity-QED

Nanocrystals and Nanowires

Nozic	Multiple Exciton Generation in Semiconductor Quantum Dots and Novel Molecules: Applications to Third Generation Solar Photon Conversion:
Klimov	Exciton-Exciton Interactions in Semiconductor Nanocrystals in the Context of Lasing and Solar Energy Conversion
Chang-Hasnain	III-V Nanowires on Si for Optical Interconnects Applications
Efros	Multi-exciton Generation by a Single Photon in Nanocrystals

Tuesday, July 24, 2007

Manybody Effects I

Koch	Many-Body Effects in the THz-Spectroscopy of Semiconductors
Kaindl	Intra-Excitonic Quantum Optics and Spectroscopy
Binder	A Many-Particle Theory Approach to Optical Refrigeration of Semiconductors
Chow	Gain and Refractive Index in Quantum-Dot Lasers

Condensation

Butov	Coherence, Condensation, and Ordering in Cold Exciton Gases
Snoke	Spontaneous Coherence of Exciton-Polaritons in GaAs Microcavities in a Trap
Kuwata-Gonokami	Dynamics of Cold Excitons in Cu2O by Excitonic Lyman Spectroscopy
Zimmerman	Towards Bose-Einstein condensation of excitons: Dynamical treatment of exciton-exciton scattering

Polarition Condensation

Dang	Polariton Condensation in CdTe Microcavities: Interaction and Coherence
Baumberg	Coherent Polariton Emission and Lasing in GaN Microcavities at Room Temperature
Savona	Polariton Bose-Einstein Condensation: Theoretical Analysis in Terms of a Two-component Diluted Bose Gas
Keeling	Polariton Condensation Beyond the Weakly Interacting Dilute Bose Gas Limit

Invited Presentations (cont)

Wednesday, July 25, 2007

Ultrafast Phenomena

Sherwin	Semiconductor Quantum Optics at Terahertz Frequencies
Norris	Dynamics of Photon-Assisted Transport in Quantum Cascade Lasers
van Driel	QUIC Injection of Electrical Currents in Silicon

Manybody Effects II

Li	Studies of Exciton Correlations with Two-Dimensional Transform Spectroscopy
Knorr	Linking Density Functional- and Density Matrix Theory: Electron dynamics at Semiconductor Surfaces and in Light Harvesting Complexes
Axt	Impact of Traveling Phonon Wave Packets of Different Origin on Quantum Dot Spectra

Thursday, July 26, 2007

Quantum Dots and Quantum Optics

Forchel	Strong Coupling Effects in Microcavities with Quantum Dots with Different Oscillator Strengths
Jahnke	Photon Statistics of Quantum-Dot-Based Microcavity Lasers
Petroff	Optical Properties of Quantum Dots and Quantum Posts
Kira	Quantum Optical State Reconstruction in Semiconductors

Cavity QED and Single Photons I

Kimble	Cavity QED with Single Atoms and Photons
Khitrova	InAs Quantum Dots in Photonic Crystal Nanocavities
Yao	Shaping to Order Single Photon Wavepacket: Control of Spin/Photon Interface in Quantum Net work
Gershoni	Semiconductor Quantum Dots as Entangled Light Sources

Cavity QED and Single Photons II

Yamamato	Quantum Repeaters and Computers Based on Electron Spins Controlled by Off-resonant Coherent State Optical Pulses
Shih	Resonantly Controlled Light Emission of Quantum Dots in Cavities
Badolato	Quantum Nature of a Strongly Coupled Quantum Dot-Nanocavity System
Wang	Cavity QED with Nitrogen Vacancy Center and Silica Microsphere

Friday, July 27, 2007

Spin Manipulation

Bayer	Coherent Electron Spin Dynamics in Quantum Dots
Bracker	Orbital and Spin States in Quantum Dot Molecules
Wu	Spin Dynamics in Semiconductor Nanostructures
Piermarocchi	Spin-Qubits and Dot Lattice Polaritons in Planar Microcavities

Optical and Spin Manipulation

Sipe	Optical Injection in Semiconductors: Another Look
Merlin	Spectral Gaps, Surface-Avoiding Modes and Mirrorless Cavities
Perakis	Magnetization Control in Ferromagnetic Semiconductors via Ultrafast Optical Excitation
Cundiff	Electron Spin Dynamics in Semiconductors

Poster Session

Thursday, July 26, 2007 - Lamar/Gibbon Room

1. Allen, Dan - *Probing Excited State Lifetimes of Electrons Bound to Donors with Terahertz Excitation and Optical Readout*
2. Binder, Rolf - *Four-Wave Mixing Instabilities in Semiconductor Quantum Wells*
3. Bristow, Alan - *Polarization-dependent 2D Fourier Transform Spectroscopy of Quantum Wells*
4. Bristow, Alan - *Isolating Excitonic Raman Coherences Using 2D Fourier Transform Spectroscopy*
5. Carter, Sam - *Echo Peak Shift Spectroscopy of Excitons in Quantum Wells*
6. Crankshaw, Shanna - *Electron g-factor Anisotropy in (110) GaAs Quantum Wells*
7. Gundogdu, Kenan - *Biexciton Formation Probed by Two-Dimensional Electronic Fourier Transform Spectroscopy*
8. Hammack, Aaron - *Kinetics of Excitons in the Laser Induced Exciton Trap*
9. High, Alex - *Control of Exciton Flux Through Tunable Potential Reliefs*
10. O'Leary, Shannon - *Optical Control of Electron Spin Precession in Semiconductor Quantum Wells*
11. Omachi, Junko - *Dynamics of an Electron-hole System in Diamond Under a Strain Field*
12. Park, Young-Shin - *Doubly Resonant Laser Cooling of a Microsphere Resonator*
13. Richards, Benjamin - *Emission Characteristics of Quantum Dots in Photonic Crystal Nanocavities*
14. Rupper, Greg - *The Effect of p-doping on Optical Refrigeration of Semiconductors*
15. Silverman, Kevin - *Spectral Holes in Semiconductor Quantum Dots at Low Temperature and Applied Electric Field*
16. Stevens, Martin J. - *Quantum Dot Single-photon Source Characterized with Superconducting Single-photon Detectors*
17. Stone, Katherine - *Two-quantum 2D Electronic Fourier Transform Spectroscopy of Biexcitons in GaAs Quantum Wells*
18. Sweet, Julian - *Photoluminescence Lifetimes of Quantum Dot Ensembles*
19. Temnov, Vasily - *Fourier Analysis in Surface Plasmon Interferometry*
20. Temnov, Vasily - *Photon Bunching in the Cooperative Spontaneous Emission*
21. Wagner, Hans-Peter - *Phase Coherent Photorefractive Effect in ZnSe Quantum Wells*
22. Wagner, Hans-Peter - *Exciton-LO-Phonon Coherences in ZnSe Quantum Wells*
23. Wahlstrand, Jared - *DC Electric Field Effects in Quantum Interference Control*
24. Wang, Jigang - *Ultrafast Enhancement of Ferromagnetism via Photoexcited Holes in a III-Mn-V Semi conductor*
25. Woggon, Ulrike - *Gain Dynamics after Ultrashort Pulse Trains in Quantum Dot based Semiconduc tor Optical Amplifiers*
26. Wu, Yanwen - *Selective Optical Control of Electron Spin Coherence in Singly Charged Quantum Dots*
27. Xu, Xiadong - *The Optical Mollow Absorption Spectrum and Gain in a Single Quantum Dot*
28. Yang, Sen - *Spontaneous coherence, interaction and kinetics of macroscopically ordered exciton state*
29. Yang, Lijun - *Simulation of Two-dimensional Correlation Spectroscopy of Excitons and Two-excitons in Semiconductors*
30. Yao, Wang - *Coherence Control of Quantum Dot Electron Spin in a Bath of Interacting Nuclear Spins*
31. Yao, Wang - *Optical Control of Spin Hall Effect and Anomalous Hall Effect in Semiconductors*

FOPS 2007 Participant List

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